ONLINE FINGERPRINT RECOGNITION

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ABSTRACT

Fingerprints are the most popularly used in biometric identification and recognition systems, because they can be easily used and their features are highly reliable. Because of their uniqueness and consistency over time, fingerprint has been used for identification for over a century, more recently becoming automated due to advancements in computing capabilities. The systems are increasingly employed into business, trading and living fields for automatic personal identification. Besides that, fingerprint recognition beyond criminal identification applications to several civilian applications such as access control, time and attendance, and computer user login. This project introduces and implementation of an online fingerprint recognition system which is capable of verifying identities of people so fast, accurate and suitable for the real time. Such a system has great utility in a variety of personal identification and access control applications by operating in minutiae extraction and minutiae matching. Minutiae extraction algorithm is implemented for extracting features from an input fingerprint image captured with an online inkless scanner. For minutiae matching, the matching algorithm has been developed. This algorithm is capable of finding the correspondences between minutiae in the input image and store template. The system will be tested on set of fingerprint images captured with inkless scanner. The recognition accuracy is found to be acceptable. This result shows that our systems meet the response requirement of online recognition with high accuracy. All the systems will be built using MATLAB software.

ABSTRAK

Cap jari adalah paling popular digunakan dalam pengenalan biometrik dan sistem pengenalan, kerana ia dapat digunakan dengan mudah dan ciri-ciri cap jari juga sangat dipercayai . Ini kerana keunikannya dan keselarian dari masa ke masa, cap jari telah digunakan dalam pengenalan untuk lebih dari satu abad, dan kini menjadi automatik seiring dengan kemajuan dalam teknologi kekomputeran. Sistem ini semakin banyak digunakan dalam bidang perniagaan, perdagangan dan bidang-bidang lain untuk pengenalan peribadi automatik. Selain itu, pengesahan cap jari di luar aplikasi pengenalan jenayah untuk aplikasi beberapa kegunaan awam seperti kawalan akses, masa dan kehadiran, dan *login* (daftar masuk) bagi pengguna komputer. Projek ini memperkenalkan dan pelaksanaan suatu sistem pengenalan cap jari yang mampu mengesahkan identiti orang-orang begitu cepat, tepat dan sesuai untuk satu-satu masa (*real time*). Sistem seperti ini memiliki kegunaan yang besar dalam pelbagai pengenalan peribadi dan aplikasi kawalan akses oleh yang beroperasi di titik-titik pengenalan "minutiae" dan pemadanan titik-titik "minutiae". Algoritma ekstraksi "minutiae" dilaksanakan untuk mengekstrak ciri dari citra cap jari yang diambil dengan pengimbas cap jari. Untuk hal pemadanan, algoritma pemadanan telah dibuat. Algoritma ini mampu menemukan hal-hal kecil dalam keserupaan antara citra cap jari yang dimasukkan dan cap jari yg tersimpan di dalam pencontoh. Sistem ini akan diuji pada serangkaian gambar yang diambil dengan pengimbas cap jari. Ketepatan pengakuan didapati boleh diterima. Hal ini menunjukkan bahawa sistem kami memenuhi keperluan dan pengakuan secara langsung dengan ketepatan tinggi. Semua sistem akan dibina menggunakan perisian MATLAB.

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LIST OF ABBREVIATIONS

PIN	-	Personal Identification Number
DNA	-	Ddeoxyribonucleic
FTIR	-	Frustrated Total Internal Reflection
MATLAB	-	Matrix laboratory software
CBFS	-	Coupled Breadth First Search
2-D	-	Two Dimensional
ADD	-	Average Absolute Deviation
dpi	-	Dots per inch
GUI	-	Graphical User Interface

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CHAPTER 1

INTRODUCTION

1.1 Overview

The increasing of society care to security threat has born new ways to protect software, hardware, building and even network system from outside party attacks. One of the security ways is by using biometric system. Such system use human body which always can be brought and not possible to leave it at home or loss during the trip. The technology becomes a popular identification and verification tool. Types of existing biometric are fingerprint, iris, eye retina, hand, gait, face and voice.

Biometric fingerprint recognition systems are the most common used biometric technology due to their long tradition. Fingerprint identification systems have been developed for more than hundred years and the identification of person through their unique fingerprint. Everyone's fingerprint pattern has unique character so that differ one to another. Equally, there is no human being having the same fingerprint, through both people of twin. The pattern formed when the human still in obstetric. A fingerprint is

made of a series of ridges and furrows on the surface of the finger. The uniqueness of a fingerprint can be determined by the pattern of ridge and furrows as well as the minutiae points. Minutiae points are local ridge characteristics that occur at either a ridge bifurcation or ridge ending.

This project describes the design and implementation of an online fingerprint recognition system which is operating in minutiae extraction and minutiae matching. Minutiae extraction algorithm is implemented for extracting features from an input fingerprint image captured with an online inkless scanner. For minutiae matching, the matching algorithm has been developed. This algorithm is capable of finding the correspondences between minutiae in the input image and store template. The system will be tested on set of fingerprint images captured with inkless scanner. The recognition accuracy is found to be acceptable. This result shows that the systems meet the response requirement of online recognition with high accuracy.

1.2 Problem Statement

As our everyday life is getting more computerized automated security systems are getting more important. Password, smart card or personal identification number (PIN) is classical approach where there have tendency to lost or to be stolen and may be forgotten. For the example, the students in few college or university have to bring their own card, not only to define them as a student but they use the card to enter the door especially at lecture hall or the office where they must put their card to the machine and the system will recognize to enter the door. Sometime they forget to bring their own card and sometimes they are easily to change and take the card that belongs to them. That’s mean, the security are still not properly useful.

1.3 Objective

The objectives of this project are to;

i. To introduce a fingerprint matching system where is capable of verifying identities.

ii. To make analysis of the identification by using minutiae matching algorithm.

1.4 Scope of Project

i. Introduce automatic technique to extract the minutiae from the fingerprint input image and concentrates on thumb.

ii. Analysis the method that match two minutiae point-set based on minutiae matching algorithm.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Biometrics recognition is the process in which a biometrics system compares incoming information with data in its system to determine whether or not it can find a match [1]. If it does, it is said to have recognized the person it is analyzing. This technology is used in security systems all over the world.

The field of biometrics relies on the fact that many humans have distinctive and unique traits which can be used to distinguish them from other humans, acting as a form of identification. A number of traits can be used for biometrics. Fingerprints are one of the oldest examples, as everyone on Earth appears to have a unique set of fingerprints at any given time. The irises of the eye are also distinctive, as are faces [2].

With a biometrics system, sophisticated processing software can be taught to identify specific individuals, and when someone approaches the system, it can determine whether or not the person is someone familiar [1]. For example, if a laboratory decides to control access to an area with fingerprinting, a list of authorized personnel would be generated and their fingerprints would be entered into the biometrics system. Any time one of these people wanted to enter the restricted area, she or he would have to present a finger to the biometrics system so that it could run the fingerprint against its database in a biometrics recognition process.

The process of biometrics recognition is not foolproof. Sometimes, a small variation causes the system to reject someone, even when that person is in the system. For example, if facial recognition is used and someone experiences a change to the face like a poorly healed broken nose, plastic surgery, or swelling due to injury, biometrics recognition may fail. Conversely, sometimes it is possible to trick a system.

In a biometric system, a physical trait needs to be recoded. The recording is referred to as an enrollment. This enrollment is based on the creation of a template. A template is the digital representation of a physical trait. The template is normally a long string of alphanumeric characteristics that describe, based on a biometric algorithm, characteristics or features of a physical trait. The algorithm will also allow the matching of an enrolled template with a new template just created for verifying an identity, called a live template [3]. When a store template and a live template are compared, the system calculates how closely they match. If the match is close enough, a person will be verified. If the match is not close enough, a person will not verify.

2.1.1 History of Fingerprint

Fingerprint offer an infallible means of personal identification. In civilization, branding and even maiming were used to mark the criminal for what he was. The thief was deprived of hand which committed the thievery. The modern history of fingerprint identification begins in the late 19^{th} century with the development of identification bureaus charged with keeping accurate records about individuals indexed, not according

to name but according to some physical attribute [4]. Henry Fauld, in 1880, first scientifically suggested the individually and uniqueness of fingerprint. At the same time, Herschel asserted that he had practiced fingerprint identification for about 20 years old [5]. This discovery established the foundation of modern fingerprint identification. It formally accepted as a valid personal identification method by law enforcement agencies and became a standard procedure in forensic. With the advent of lives can fingerprinting and availability of cheap fingerprint sensor, fingerprint are increasing used in government and commercial application for positive person identification [5]. The conclusion of the history is shown in Table 2.1.1

Table 2.1 The History of Fingerprint [6][7].

Year	Description
1686	Marcello Malpighi, a professor of anatomy at the University of Bologna, noted in his treatise; ridges, spirals and loops in fingerprints. He made no mention of their value as a tool for individual identification. A layer of skin was named after him; "Malpighi" layer, which is approximately 1.8mm thick.
1823	In 1823, John Evangelist Purkinje, an anatomy professor at the University of Breslau, published his thesis discussing 9 fingerprint patterns, but he too made no mention of the value of fingerprints for personal identification.
1856	Sir William Hershel, Chief Administrative Office, Bengal India, first used fingerprints on native contracts.
1880	Dr. Henry Faulds, who was working in Tokyo, Japan, published an article in the Scientific Journal, "Nautre" (nature). He discussed fingerprints as a means of personal identification, and the use of printers ink as a method for obtaining such fingerprints. He is also credited with the first fingerprint identification of a greasy fingerprint left on an alcohol bottle.

1882	Gilbert Thompson of the U.S. Geological Survey in New Mexico, used his own fingerprints on a document to prevent forgery. This is the first known use of fingerprints in the United States.
1883	In Mark Twain's book, "Life on the Mississippi", a murderer was identified by the use of fingerprint identification. In a later book by Mark Twain, "Pudd'n Head Wilson", there was a dramatic court trial on fingerprint identification. A more recent movie as made from this book.
1891-1895	In 1891,the introduction of fingerprints for criminal identification in England and Wales, using Galton's observations and revised by Sir Edward Richard Henry. Thus began the Henry Classification System, used even today in all English speaking countries. In 1892, First systematic use of fingerprints in the U.S. with the New York Civil Service Commission for testing. Dr. Henry P. DeForrest, a pioneer in U.S. fingerprinting. In 1894, The use of fingerprints began in Leavenworth State Penitentiary in Kansas, and the St. Louis Police Department. They were assisted by a Sergeant from Scotland Yard who had been on duty at the St. Louis Exposition guarding the British Display.
1901	Introduction of fingerprints for criminal identification in England and Wales, using Galton's observations and revised by Sir Edward Richard Henry. Thus began the Henry Classification System, used even today in all English speaking countries.
1904	The use of fingerprints began in Leavenworth Federal Penitentiary in Kansas, and the St. Louis Police Department. They were assisted by a Sergeant from Scotland Yard who had been on duty at the St. Louis Exposition guarding the British Display.

2.2 Fingerprint as a Biometric

A smoothly flowing pattern formed by alternating crests (ridges) and troughs (valleys) on the palmar aspect of hand is called a palmprint as shown in figure 2.1. Formation of a palmprint depends on the initial conditions of the embryonic mesoderm from which they develop. The pattern on pulp of each terminal phalanx is considered as an individual pattern and is commonly referred to as a fingerprint [8]. A fingerprint is believed to be unique to each person. Fingerprints of even identical twins are different.

Fingerprints are one of the most mature biometric technologies and are considered legitimate proofs of evidence in courts of law all over the world. Fingerprints are, therefore, used in forensic divisions worldwide for criminal investigations. More recently, an increasing number of civilian and commercial applications are either using or actively considering using fingerprint-based identification because of a better understanding of fingerprints as well as demonstrated matching performance than any other existing biometric technology [8].

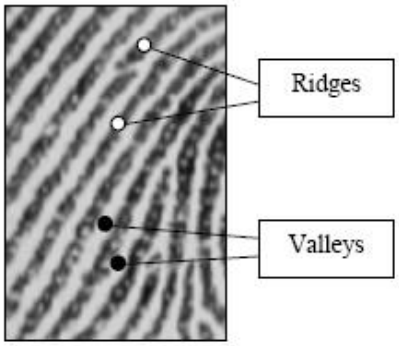

Figure 2.1: Ridges and valleys on a fingerprint image

People have tiny ridges of skin on their fingers because this particular adaptation was extremely advantageous to the ancestors of the human species. The pattern of ridges

and "valleys" on fingers make it easier for the hands to grip things, in the same way a rubber tread pattern helps a tire grip the road [9].

The other function of fingerprints is a total coincidence. Like everything in the human body, these ridges form through a combination of genetic and environmental factors. The genetic code in DNA gives general orders on the way skin should form in a developing fetus, but the specific way it forms is a result of random events. The exact position of the fetus in the womb at a particular moment and the exact composition and density of surrounding amniotic fluid decides how every individual ridge will form.

Consequently, fingerprints are a unique marker for a person, even an identical twin. And while two prints may look basically the same at a glance, a trained investigator or an advanced piece of software can pick out clear, defined differences.

2.3 Fingerprint Classification

Fingerprint recognition technology is divided into two distinct processes to define a problem of resolving the identity of a person with different inherent complexities which is verification and identification [8].

In the verification process the user states who he or she is and a fingerprint is taken and compared to the user's previously registered fingerprint. If the fingerprints match, the user is "verified" as who he or she says he or she is. Since the newly acquired fingerprint is compared to only one stored fingerprint, this is called a one-to-one matching process (1:1) as shown in figure 2.2 (b). As in the enrollment process where shown in figure 2.2 (a), when fingerprint verification is done, only the fingerprint template is used in the comparison, not the actual image of the fingerprint.

In the identification process the user doesn't need to state who he or she is. A fingerprint is taken and compared to each fingerprint in the database of registered users. When a match occurs, the user is "identified" as the existing user the system found. Since the newly acquired fingerprint is compared to many stored fingerprints, this is called a one-to-many matching process (1:N) as shown in figure 2.2 (c). As in the

verification process, when fingerprint identification is done, only the fingerprint template is used in the comparison, not the actual image of the fingerprint.

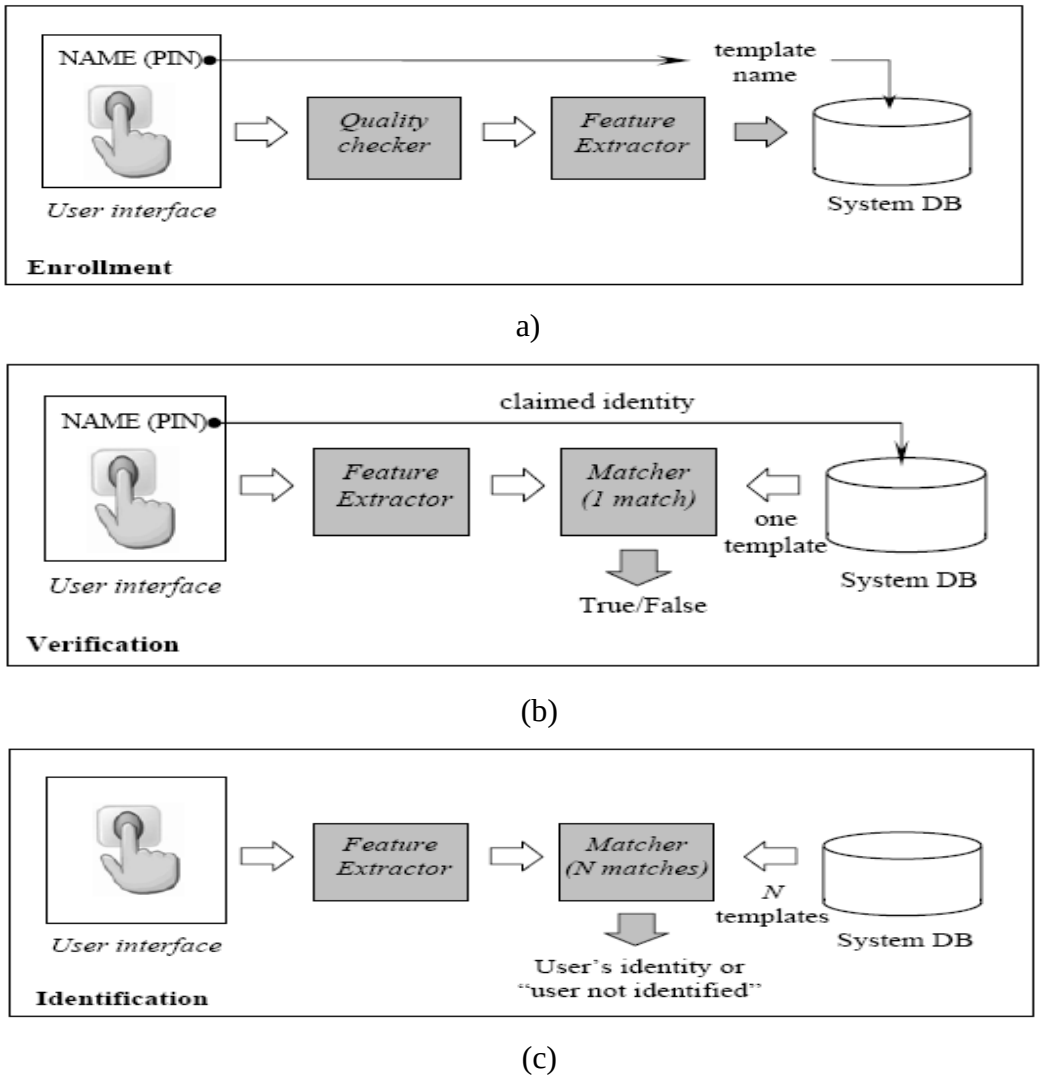

Figure2.2: Block diagrams of (a) enrollment, (b) verification, and (c) identification tasks. at the verification stage, the template

2.4 Type of Fingerprints

Fingerprint can be dividing into the three (3) major patterns. The patterns are arch, loop and whorls. Arches are different from loop because arches have more open curves. Arches account for approximately 5% of the ridge pattern in a given population.